Progress in Implementing Non-Cr^{6+} Surface Finishes for U.S. Navy and Marine Corps Aircraft

Craig Matzdorf
Materials Engineering Division
Naval Air Warfare Center
U.S. Navy

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **AUG 2012**	2. REPORT TYPE	3. DATES COVERED **00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE **Progress in Implementing Non-Cr6+ Surface Finishes for U.S. Navy and Marine Corps Aircraft**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Air Warfare Center,Materials Engineering Division,22347 Cedar Point Road,Patuxent River,MD,20670-5304**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
ASETSDefense 2012: Sustainable Surface Engineering for Aerospace and Defense Workshop, August 27-30, 2012, San Diego, CA. Sponsored by SERDP/ESTCP.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**12**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Agenda

- Navy and Marine Corps Aircraft Applications
- Progress in Implementing Alternatives
- R&D Efforts

Applications

✈ Conversion coatings for Aluminum: MIL-PRF-81706/5541 Type IA (general use)

- Type II excludes hexavalent chromium (8 qualified products from 4 companies)
- Includes products for immersion, spray, wipe and applicator pen methods
- Only qualified products to date for Class 1A are based on trivalent chromium
- **Key aspect overlooked**: qualified products provide passivation to aluminum which lowers corrosion current densities 10-1000 fold in galvanic interfaces
  - ability to suppress current and potential is a possible new requirement
  - galvanic test is being considered as a new requirement
  - technical boundaries will be established through ONR-supported work on DC polarization measurements of protective coatings, corrosion modeling, and verification

✈ Conversion coatings for Aluminum: MIL-PRF-81706/5541 Type 3 (electrical applications/unpainted)

- Type II excludes hexavalent chromium (7 qualified products from 5 companies)
- Qualified products to date are based on trivalent chromium except one non-Cr
- Similar passivation issues/potential changes as Class 1A coatings

NAVAIR

Applications

- Aluminum Anodizing: MIL-A-8625
  - Process Types IC (boric-surfuric acid), IIB (thin-film sulfuric acid), and II (sulfuric acid) and III (sulfuric acid) do not contain chromium
  - No discrimination in sealer chemistry per current specification language
  - Draft revision includes separate seals for non-chromate options including water, nickel, cobalt, trivalent chromium, and duplex

- Conversion coatings and Anodizing for Magnesium: SAE-AMS-M-3141
  - Specification needs to be revised to include a Type for non-chromium conversion coating (current Type VIII specifically calls out chromate conversion coating) and Types for new anodize processes like Tagnite and Keranite
  - More challenging to change due to control by commercial entity

- Conversion coatings for Titanium:
  - Conversion coating needed for paint adhesion
  - No current specification
  - Unknown/undefined role of conversion coating in passivating Ti- may be important for galvanic couples

Related/Linked Applications

- Priming:
  - MIL-PRF-23377: high solids epoxy primers
    - Class N in place for Types I and II (low IR reflection)
    - Two products qualified to Type I, one to Type II
    - Galvanic protection generally better than MIL-PRF-85582, long re-coat times (up to 4 hrs)
  - MIL-PRF-85582: water reducible epoxy primers
    - Class N in place for Types I and II (low IR reflection)
    - One product qualified to each type
    - Preferred to -23377 by users due to short (1hr) re-coat times
  - TT-P-2760: high solids polyurethane primers
    - Class N in place for Types I and II (low IR reflection)
    - No qualified products

Progress in Implementing Alternatives

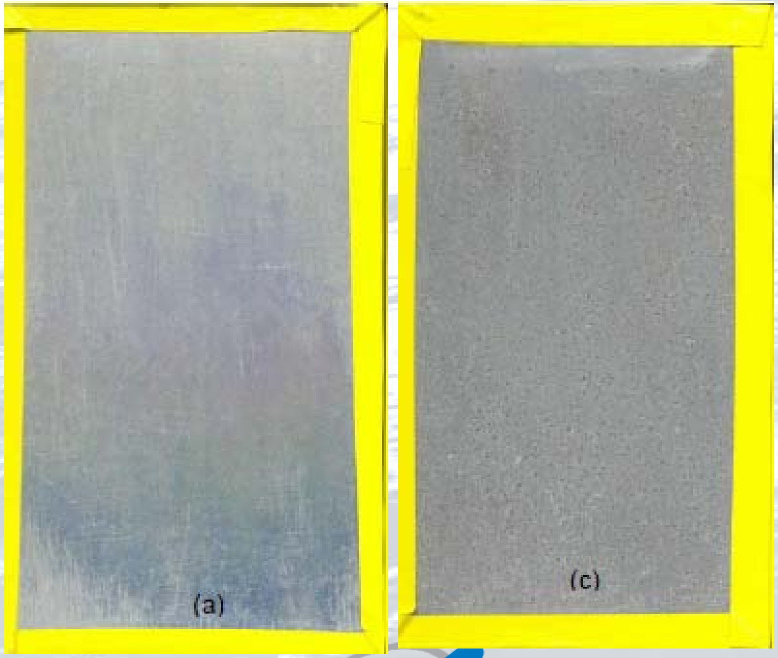
- **Inorganic Metal Finishing Coatings and Processes**
  - Alternatives authorized and used for
    - Aluminum and magnesium anodizing
    - Hard Chrome Plating
    - Type II conversion coating on aluminum alloys under chromated primer: Class 1A applications
    - Type II conversion coating on Alumiplate under chromated primer
    - Sealing of Type IC, IIB, II and III anodize using Type II conversion coatings (TCP)
  - Alternatives pending authorization and use
    - Conversion coating titanium (TCP and Alodine 5700)
    - Sealing of phosphate coatings (ChromiPhos)
  - Alternatives being assessed in demonstration and validation projects
    - Type II conversion coating on aluminum alloys with non-chromate primers per MIL-PRF-23377 Class N and MIL-PRF-85582 Class N
    - Conversion coating magnesium
    - Post treatment of IVD aluminum
    - Post treatment of IZ-C17$^+$ ZnNi
    - Type II conversion coatings on aluminum: Class 3 applications

Featured Effort: Mg Conversion Coating Dem/Val

✈ OSD Corrosion IPT funded effort to complete FRC validation of coating process and performance on representative alloys and scrap parts

- FRC SE (Jacksonville) has 730-gallon process tank for Mg conversion coating
- Operates near 200F
- Change to trivalent chromium process offers multiple benefits:
    - Energy savings (75-90F vs 200F)
    - EOSH improvement- non Cr^{6+} process and coating
    - common product- same TCP as being planned for Al anodize sealer and conversion coating
    - Equal or better paint adhesion and corrosion protection

Alternative | Cr6+ Control



Progress in Implementing Alternatives

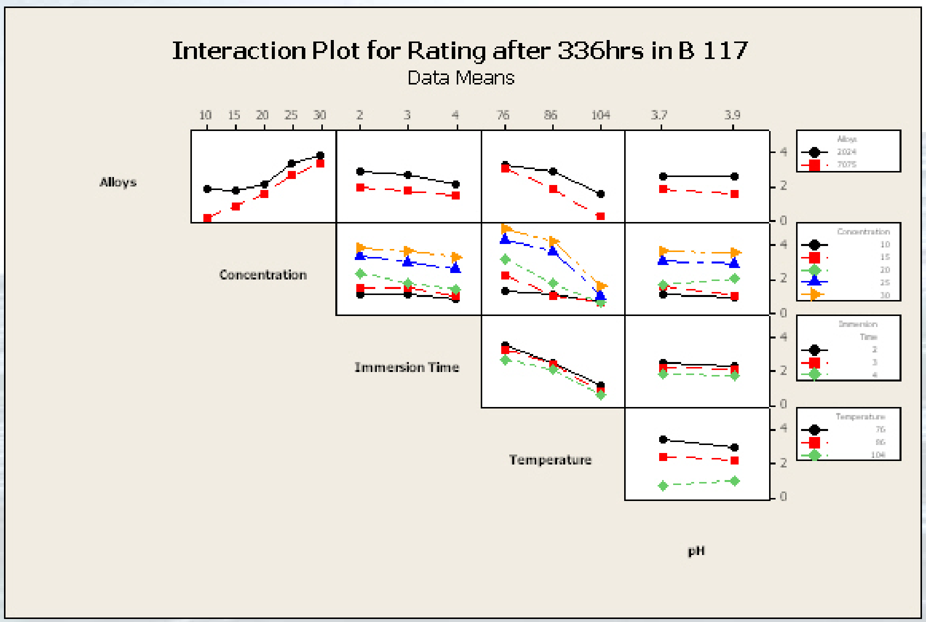
- **Organic Coatings and Processes**
  - Alternatives authorized for
    - Priming of support equipment (MIL-DTL-53022)
    - Sealing- various specifications
    - Priming aircraft/components: scuff sand and overcoat applications
  - Alternatives pending authorization
    - None currently
  - Alternatives being assessed in R&D
    - Primer in coating systems with chromated or non-chromated conversion coatings or anodize
    - Galvanic (metal rich) primers in total NC systems

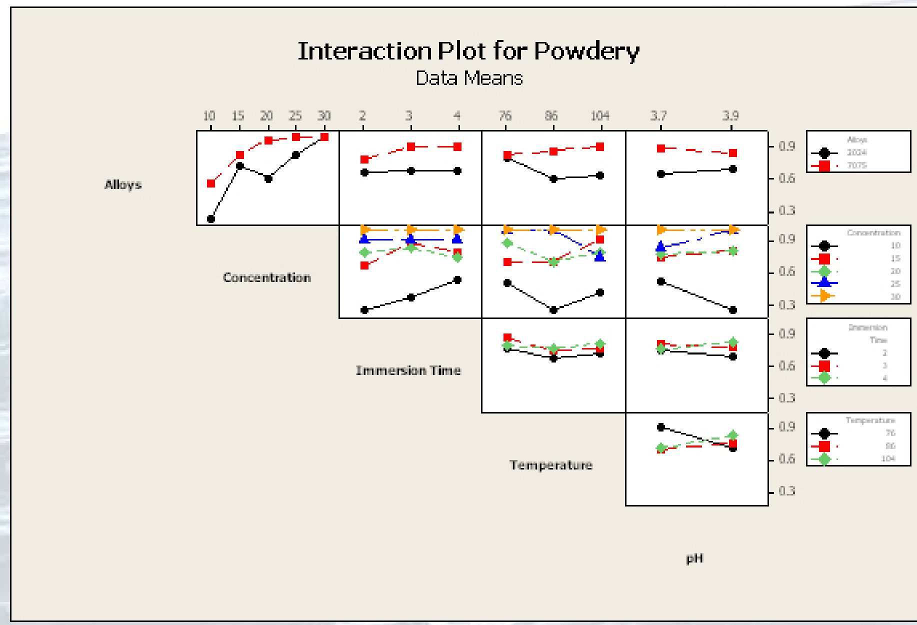
Research & Development and Implementation Progress

- **Ongoing**
  - Type II conversion coating touch up pens- qualifications completed, not being implemented at FRCs for now
  - TCP passivation of IVD Aluminum- field testing underway
  - Conversion coating Magnesium and Titanium- FRC testing underway
  - Metal rich primer- lab development
- **New in FY12 and continuing**
  - NC Primer Field Validation– Supports implementation of qualified Type I and Type II Class N primers at NAVAIR user sites. **Includes Type I and II conversion coatings**.
  - Type II, Class 3 Conversion Coatings; electronics requirements- linked with NASA effort
  - IZ- C17+ zinc-nickel, with trivalent chromium passivation(s)- FRC demo underway
  - Type II conversion coating assessement of Surtec 650V- lab assessment underway
- **Planned for FY13**
  - TCP process variable optimization- pH and temperature of deox and TCP rinses; TCP concentration, pH, immersion time, temperature; multiple TCP products; multiple metal processes- acid & base etch, mild deox

Featured Effort: Surtec 650V Process Optimization

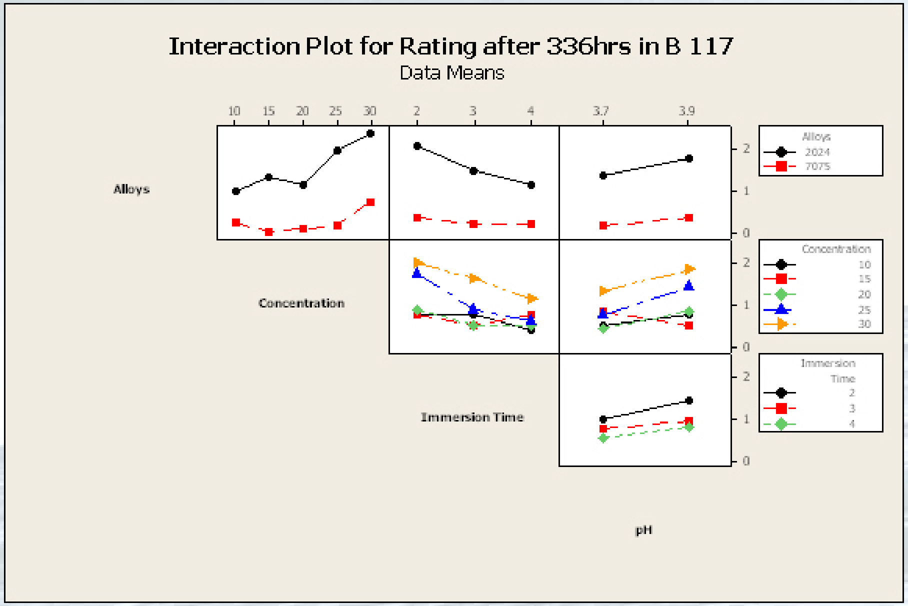
- NISE/219 funded effort to optimize performance of Surtec 650V
- Sensitivity to operating variables slowing implementation of Type IIs
- Minitab interaction plots show:
  - large effect due to bath operating temperature
  - large effect due to bath concentration
  - minor effect due to immersion time
  - minor effect due to pH

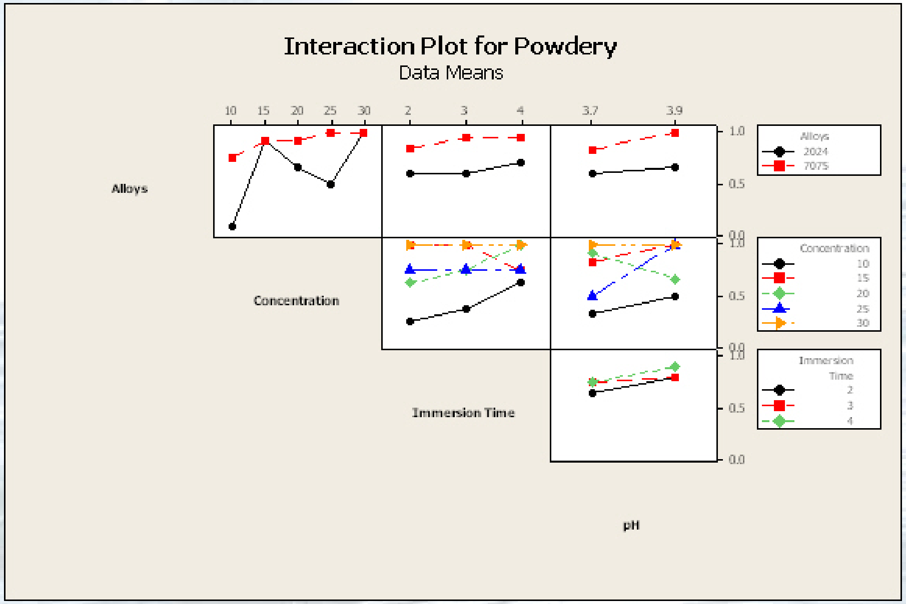




Featured Effort: Surtec 650V Process Optimization

✈ Focused interactions at 104 F immersion temperature show:
- large effect due to bath concentration
- moderate effect due to immersion time
- moderate effect due to pH





✈ FY13: plan to look at alternate surface preps (acid and base etch), temps around 104 F and lower concentration (5%) in effort to optimize for both alloys and corrosion and powder formation- share information with Surtec and users

✈ FY13: plan to expand to other TCP products

Summary

✈ Top level strategy in place to systematically address $Cr6^{+}$ in metal finishing (and painting)

✈ Alternatives partially implemented by FRCs, fleet and OEMs based on business cases-

- incremental transition planned to continue
- each user/location has different drivers due to mix of local/state/federal regulations and laws

✈ Heavy focus on spray applied products and coatings removed during maintenance due to higher exposure risks from mists and dusts

✈ R&D ongoing and focused on improved coatings

- Improved corrosion properties for all
- Additional Class N, Type II primers
- 1-hr re-coat for high solids primers

NAVAIR